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Social, conservation and economic implications of rabies in Australia

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ABSTRACT

Biophilia, our inherent love of living things, is a major driver of the modern conservation ethic worldwide. Australians are particularly fond of wildlife and consequently, our fauna are key to our national image. As a nation, we are known for our relatively carefree attitude towards some of the world's most dangerous animals, including venomous snakes and spiders, as well as sharks. This has arisen largely because we are familiar with these species, understand the actual level of risk they pose and have some idea of how to safely interact with them.

Unfortunately, the relationship between Australians and our wildlife could change significantly. Canine rabies, an infamous, fatal, viral zoonosis, is now less than 300 kilometers from the Australian mainland. We must face the possibility of a 'when', rather than 'if' scenario and begin to plan for rabies management on a continent where virtually the entire population is naïve.

Human and animal health would be affected. People, domestic animals and wildlife may die. Perhaps worse, in terms of scale, is the likely change in the Australian way of life, including the way we perceive, value and interact with wildlife, pets and livestock. Of course, rabies is endemic in many other countries and people continue to actively engage in conservation programs, but these people have had a long time to come to terms with the risk in their midst and many undergo prophylactic vaccination to enable them to work with wildlife.

Here, we discuss Australia's impending future with particular regard to how canine rabies could change our lives, the impacts it could have on wildlife conservation and the steps we must take to be prepared.

Key words: Conservation, dingo, economic, human-wildlife dimensions, perceptions, rabies, domestic dog

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Introduction

Human-dimensions researchers have documented Australians' affinity for wildlife. Surveys have found that Australians enjoy living with wildlife and value it highly (Miller 2003; FitzGibbon and Jones 2006; Russell *et al.* 2011; Wilks *et al.* 2013). However, these 'biophilic' attitudes (Wilson 1984) do not necessarily extend to 'pest' species, i.e. those which have a negative impact on humans, even when they are native (e.g. Fitzgibbon and Jones 2006; Dowle and Deane 2009).

It is rare that negative interactions between humans and wildlife culminate in human death, but when this does occur, media coverage and political agendas can escalate, with the potential to sway public perception of wildlife and negatively impact conservation efforts (Conover 2001; Evensen 2008; Decker *et al.* 2010; Degeling and Kerridge 2013). Zoonotic disease transmission is one way that wildlife can cause human death. When these tragic circumstances occur, conservation efforts can be threatened, and the human dimensions of wildlife management becomes particularly important (Decker *et al.* 2001).

Canine rabies

Canine rabies is a fatal, viral zoonosis which remains a significant issue for human health and wildlife management worldwide (Sterner and Smith 2006). There is no cure for rabies, although it is preventable by vaccination. Rabies is most commonly transmitted to susceptible hosts (any mammal) through the bite of an infected dog. This disease is now less than 300 kilometres from Australia's mainland (Sparkes *et al.* 2014), in the Tanimbar Islands and continues to spread eastwards through the Indonesian archipelago (Tenzin and Ward 2012, Putra *et al.* 2013) and potentially into Papua New Guinea. With more than 23,000 human movements between Papua New Guinea, the Torres Strait Islands and Cape York Peninsula each year

(Brain 2013), it is possible that it is only a matter of time before Australia succumbs to a rabies outbreak (Sparkes *et al.* 2014).

Fear will change attitudes towards wildlife

Unfortunately, Australian communities do not sufficiently understand the implications of a rabies outbreak and its potential effects on wildlife, domestic animals and themselves. Australians' ignorance may quickly escalate to fear. Widespread disease in wildlife populations might encourage humans to view a broad range of wildlife as pests, rather than a resource worth conserving (Peterson *et al.* 2006), due to concern about their potential role as rabies vectors.

Canids and Chiropterans, particularly flying foxes (*Pteropus spp.*), are at risk of increased negative perceptions from humans, should rabies reach the Australian continent. Management of Australia's wild dogs (including dingoes *Canis lupus dingo*, domestic dogs *C.l. familiaris* and cross-breeds *C.l. dingo* X *C.l. familiaris*) is already complex due to their extensive distribution, impacts on agricultural production and dingoes' status as a native animal (Fleming *et al.* 2001; Fleming *et al.* In press). In some areas of public land, such as National Parks, conservation of dingoes is considered important, but on private land where wild dogs threaten agricultural production, landholders poison, trap and/or shoot them. Although many Australian's probably feel they are unlikely to encounter wild dogs, these animals also occur in peri-urban areas where they are often closely associated with humans (Allen *et al.* 2013; Newsome *et al.* 2013). This close proximity already causes some concern for health and safety (Tumaneng-Diete 2006) but with the potential introduction of canine rabies to Australia, the lines between conservation and control will become increasingly blurred. There is little doubt that the role wild dogs will play as vectors of rabies in Australia will contribute to the debate about management of wild dogs in the future.

Bats too, stand to suffer from Australian's ignorance with regard to canine rabies. Currently, many Australians seem to not adequately understand the risks associated with Australia's bat-borne zoonotic diseases, e.g. Hendra and the Australian Bat Lyssavirus (ABLV) (Degeling and Kerridge 2013; Hayes 2013). Education programs to allay fear and improve knowledge about the benefits of bats to ecosystem health are required to alter current perceptions; particularly of those communities in close proximity to bat colonies.

International experience

Until rabies reaches Australia, information about public attitudes toward this significant zoonotic disease can only be drawn from international experience. A survey conducted in Munich, southern Germany assessed community members' fear and attitudes towards urban foxes (n=779) and found 35% of respondents were afraid of rabies, 75% felt foxes were a danger to people because they transmit disease and 65% wanted a marked reduction in the number of foxes in the community (Konig 2008). Similarly, Illinois residents were surveyed to determine their attitudes towards wildlife with 94% of respondents (n=805) indicating wildlife was important to them, but 57% were concerned about contracting diseases from wildlife (Mankin *et al.* 1999).

There is hope, however, that possible negative attitudes towards wildlife, in the face of newly arrived rabies, may be assuaged with time. Mankin *et al.* (1999) found that although the majority of respondents to a survey were concerned for their health, this did not appear to affect participation in non-consumptive forms of wildlife recreation activities. Similarly, although the risk of rabies to humans, domestic animals and wildlife was perceived to be high by community members, Hanisch-Kirkbride *et al.* (2013) found that respondents in the US were more concerned for the susceptibility of wildlife to disease than for humans or domestic animals.

Educating people about rabies

Even in countries where rabies is endemic, community members can lack vital knowledge on rabies transmission and prevention (Bingham *et al.* 2010; Dzikwi *et al.* 2012; Rumana *et al.* 2013). For example, in Texas, USA, 98% of respondents (n=922) to a household survey had heard of rabies, but only 59% knew that exposure to rabies without treatment could lead to death (Bingham *et al.* 2010). Similarly, Matibag *et al.* (2007) found that 90% of respondents (n=1570) knew that dogs were the most common reservoir of rabies in Sri Lanka, but only 79% knew rabies is fatal.

This lack of knowledge, combined with limited medical facilities in many regions (Warrell *et al.* 2007), contributes to the number of untreated rabies cases, with dire consequences. Annually, more than 55,000 people die from rabies (Knobel *et al.* 2005), with most of those deaths occurring in Asia and Africa (Warrell *et al.* 2007).

To reduce human deaths from rabies, education programs have been recommended in many countries (Vanak *et al.* 2007; Bingham *et al.* 2010; Burgos-Caceres 2011; Lapiz *et al.* 2012). In the Philippines, a rabies prevention and elimination project was initiated in 2007, including an educational component to raise awareness of the disease (Lapiz *et al.* 2012). As a direct result of the program, the number of dog-bite victims that sought medical attention after potential rabies exposure increased (Lapiz *et al.* 2012). Community education programs highlighting potential risks, methods to accurately identify infected individuals and preventative strategies could also be useful for rabies preparedness in Australia, particularly in northern Australia, where the risk of entry is highest.

Ecotourism

Beyond impacts on wildlife from shifts in public attitudes, if rabies enters Australia there is potential for significant impacts on the tourism industry. In 2012, ecotourism (including visiting National Parks, bush walking and visiting wildlife parks) contributed $4 billion to the Australian economy (Department of National Parks, Recreation, Sport and Racing 2013). Conservation of ecosystems, including native wildlife, are promoted and supported as a result of ecotourism, through financial support and education of tourists (Buckley 2010; Feck and Hamann 2013).

Potential interactions with Australian wildlife are a draw-card for many ecotourism operators (e.g. "touch and feel Australian wildlife", "hold a koala"- Cleland Wildlife Park promotion: www.environment.sa.gov.au/clelandwildlife/Home). The Australian ecotourism hotspot; Fraser Island, attracts approximately 400,000 tourists annually (Ecosure 2012), with the majority of visitors expecting some form of interaction with dingoes (Burns and Howard 2003). Already, despite efforts from National Park rangers, negative interactions do occur between humans and dingoes and this has led to the destruction of these animals at tourist 'hot spots' (Environmental Protection Agency 2001). The destruction of dingoes in these circumstances has led to public outcry and negative media attention (Burns and Howard 2003).

In the advent of a rabies outbreak in Australia, initial management responses may involve the culling of wild dogs (including dingoes) and other mammals from infected areas, which may also result in negative media coverage. Further, ecotourism may decline as Australia loses its canine-rabies-free status and people become afraid of interactions with wild animals for fear of infection.

Domestic animals

Domestic dogs are known reservoirs for many important human and wildlife diseases including rabies and canine distemper (Cleaveland *et al.* 2000; Daszak *et al.* 2000; Vanak *et al.* 2007; Salb *et al.* 2008; Cleaveland *et al.* 2012). Prager *et al.* (2012) found that domestic dogs were the reservoir for rabies and likely played a critical role in the maintenance and transmission of the disease to native carnivores in Northern Kenya. Woodroffe *et al.* (2012) also found that wild dogs (*Lyacon pictus*) living in close proximity to domestic dogs were at greater risk of exposure to canine parvovirus, *Ehrlichia*, *Neospora* and rabies virus than those with limited contact. These results suggest that control and management of some important wildlife and human diseases should target domestic dogs rather than focus on native wildlife populations (Vanak *et al.* 2007; Bryan *et al.* 2011; Woodroffe *et al.* 2012) and this may also be the case in Australia.

The domestic dog population in Australia was estimated at 3.4 million in 2009, with 36% of Australian households owning a dog (Australian Companion Animal Council 2010). If rabies were to enter Australia, many of these dogs would need to be vaccinated to prevent the spread of rabies and protect domestic dogs, humans and wildlife against the disease. At an average cost of AUD$2.56 per dog (Kayali *et al.* 2006; 1 XOF = 0.00231 AUD, www.oanda.com, accessed 6 January 2014), and assuming maximum areal extent of the outbreak, annual domestic dog rabies vaccine in Australia could cost AUD$8.7 million, with these costs and the costs of vaccination being borne by Government under the current Emergency Animal Disease Response Agreement between the Australian Government and State and Territory Governments (Willis 2013).

An option proposed by Australian government authorities for the control of a rabies outbreak is to strengthen domestic animal management through 'seizing, and detaining or destroying animals not properly controlled or vaccinated' (Animal Health Australia 2011). Banks (1992) further recommended that animals wearing a tag (correctly licensed and vaccinated) should be kept in confinement for a fixed period of time, while animals not wearing correct identification should be euthanized when captured, dismissing any notion of potential rehoming through a rescue organisation. This strategy will likely be met with negative media attention and will impact rescue rates from pounds and the willingness of volunteers and community members to support rescue organisations. Rather than waiting for an Australian rabies outbreak as justification to strengthen domestic animal management, proactive management will reduce response times and improve chances of containing such an outbreak.

Oral rabies vaccination in wildlife

Although there has been great success in the control, and even eradication of rabies from countries in Europe and North America, considerable costs are associated with these outcomes (Freuling *et al.* 2013). The costs associated with oral rabies vaccination (ORV) of foxes (*Vulpes vulpes*) in European countries has ranged from AUD$379,101 to AUD$216,606,822 (1 € = 1.52478 AUD, www.oanda.com, accessed 11 February 2014), with the control of rabies taking between 5 and 26 years depending on the country involved (Freuling *et al.* 2013). Annual vaccination programs for wildlife and domestic animals remains an ongoing cost for many countries around the world.

Engagement of volunteers or community members may decrease the costs associated with some aspects of ORV programs, however the highest costs associated with an

ORV program is that of bait manufacture (AUD$1.12 to 1.42 depending on bait type), with an estimated total cost of AUD$107 km^{-2} at a bait density of 66 km^{-2} for carnivores (Slate *et al.* 2005; 1 US = 1.11849 AUD, www.oanda.com, accessed 11 February 2014). Targeting gray foxes (*Urocyon cinereoargenteus*) and coyotes (*Canis latrans*) in Texas, USA, ORV campaigns were estimated to cost AUD$54 km^{-2} (Sterner *et al.* 2009).

Aerial baiting for the control of wild dogs occurs annually in parts of Western Australia (WA), Queensland, South Australia and New South Wales (NSW) at bait densities of 16 km^{-2} (NSW Environment Protection Authority 2010), while in parts of WA and NSW, baiting rates of up to 10 baits km^{-1} are used to control foxes. The national annual costs for such control campaigns are about $9.87m for wild dogs and $7.96m for foxes (from Gong *et al.* 2009). There have been no recent cost assessments of aerial baiting, but Thompson and Fleming (1991) found a strong relationship between the quantity of bait required and the overall cost of aerial baiting programs in north east NSW in 1988, where the mean cost of baiting was $4.21 kg^{-1} (current value Au$8.55 kg^{-1}, www.abs.gov.au/websitedbs/d3310114.nsf/home/consumer+price+index+inflation+calculator).

Based on the above estimate, a baiting density of 16 km^{-2} and an average wild dog bait weight of 250 grams (NSW Environment Protection Authority 2010), annual aerial baiting campaigns in north-east NSW are estimated to cost $34 km^{-2}. This figure is comparable with costs associated with ORV campaigns undertaken in the US (Sterner *et al.* 2009; Slate *et al.* 2005). However, ORV campaigns are generally carried out twice per year (Freuling *et al.* 2013), targeting multiple canid species (Sterner *et al.* 2009; Slate *et al.* 2005) and similar would be expected for successful ORV in Australia, increasing annual costs above those already observed for the control of wild dogs and foxes.

Human costs

In addition to the vaccination of wildlife and domestic animals, significant costs are also associated with post-exposure-prophylaxis (PEP) of exposed humans to the disease. The direct costs of human PEP treatment has been estimated at between AUD$2,658 and $2,868 per exposed person in the US (Kreindel *et al.* 1998; Shwiff *et al.* 2007; Vaidya *et al.* 2010). As rabies is a Category 1 disease in Australia (Willis 2013), the costs associated with PEP treatment will likely fall with the Government's healthcare system.

Conclusion

Australia is unique in that it has never had endemic terrestrial rabies. Although other countries have learnt to live with rabies endemism, this has occurred over a long period of time. A new wildlife-borne disease in Australia is likely to cause fear in the short-term and may reasonably be expected to impact negatively on people's attitudes towards wildlife. Likely negative consequences will be felt in reduced support for conservation efforts, changes to the nature and frequency of human interactions with domestic animals and significant economic losses. Although culling of free-roaming dogs might be included in rabies control strategies, we are not recommending the broad-scale culling of wildlife. To reduce risks and associated costs to humans, domestic animals and wildlife of endemic rabies or a rabies outbreak, the current, relaxed attitude of many Australians towards domestic animal management would need to change. Achieving this important change will require strategic education programs to raise appropriate awareness of zoonosis prevention in the human population.

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